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L9: Entry 4 of 7 File: USPT Apr 24, 1984

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TITLE: Equipment for storage of energy under kinetic form and recovery thereof in electric form and method of using such equipment

DATE-ISSUED: April 24, 1984

INVENTOR-INFORMATION:

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US-CL-CURRENT: 310/90.5

CLAIMS:

What is claimed is:
1. An equipment for storing energy under kinetic form and uninterrupted recovery of this energy in electric form in a gravity field, of the type comprising an enclosure, a stator within said enclosure, a flywheel rotor adapted to be magnetically suspended relative to said stator and disposed within said enclosure, touch-down bearings between said stator and said rotor to support said rotor when the latter is not suspended magnetically, and means for magnetically suspending said rotor relative to said stator and maintaining said rotor in equilibrium relative to said stator, including permanent magnet rings on said stator opposite an equivalent number of permanent rings on said rotor for creating a lifting force on said stator, a double electromagnet comprising a permanent magnet ring having electromagnet coils on each side of said last magnet ring with said ring being mounted on said rotor and with said electromagnet coils being mounted on said stator, axial rate sensor means to detect the axial rate of the rotation of said rotor and comprising coils fixed to said stator adjacent a magnet attached to said rotor, servoloop means for maintaining applied forces including the weight of said rotor compensated with lifting forces of said opposing permanent magnet rings, by connecting said electromagnet coils in feedback relationship with said rate sensor coils, a

lift-off logic in said servoloop means to control the sense of initial current of said servoloop means when said rotor is supported by said touch-down bearings and no axial rate is detected by said rate sensor, damping means to prevent excessive radial excursion and comprising opposing permanent magnets and a centering member passing between them and a motor and a generator having at least one armature mounted for rotation with said rotor.

2. An equipment as claimed in claim 1, wherein a fixed shaft is part of said stator, said rotor being bored through, and mounted around the shaft, said permanent magnet rings, double electromagnet and damping means being disposed in the bore between said fixed shaft and said rotor.

3. An equipment as claimed in claim 1, wherein a rotating shaft is mounted with and rotates with the rotor, extensions of said rotating shaft outside said rotor being used for receiving rotating parts of said permanent magnet rings and double electromagnet having fixed elements connected to said stator.

4. An equipment as claimed in claim 3, wherein an upper extension of said rotating shaft carries a knuckle joint mounted on ball bearings and which in the absence of an axial suspension provides for the mechanical contact with a fixed part of the equipment.

5. An equipment as claimed in claims 3 or 4, wherein another ball bearing is provided on a lower extension of said rotating shaft, the mechanical play on this level being cancelled by the action of an electromagnet under certain conditions of operation.

6. An equipment as claimed in claim 3 or 4, wherein several radial damping devices are provided on any point on the generatrix of said rotor, and comprises a biased magnetic circuit closing through two circumferential gaps on said rotor, any variation of said gaps resulting in a magnetic field variation producing an electromotive force in said electromagnet coils which in its turn produces after amplification a current in a corrective magnetic circuit in said devices.

7. An equipment as claimed in any of claims 1, 2 or 3, wherein said permanent magnet rings on said stator disposed opposite an equivalent number of said permanent magnet rings on said rotor are such that said magnet rings of said stator are placed radially adjacent one another and said magnet rings of said rotor are placed radially adjacent one another concentrically with respect to one another.

8. An equipment as claimed in claim 7, wherein said magnet rings of said rotor are mounted with vertically opposing rings of said stator in a magnetic relationship of mutual attraction.

9. An equipment as claimed in claim 1, wherein said lift-off logic produces reversal of current in said electromagnet coils when the current therein reaches a predetermined level.

10. An equipment as claimed in claim 1, characterized in that said lift-off logic produces reversal of current in said electromagnetic coils when the current therein has increased for a predetermined time period without said rotor being magnetically suspended and lifted off said touch down bearings.

11. An equipment as claimed in claims 1, 2, 3, or 4, characterized in that said permanent magnet rings of said stator opposite to an equivalent number of said permanent magnet rings of said rotor are such that said magnet rings are magnetized in the same direction as the axis of said rotor, polar pieces connecting the ends of pairs of said magnet rings opposite the ends forming gaps with opposing ones of said magnet rings positioned vertically.
12. An equipment as claimed in claims 1, 2, 3, or 4, characterized in that said axial rate sensor comprises coils fixed to said stator, said coils comprising two coils connected to add the electromotive forces induced therein.
13. An equipment as claimed in claim 11, characterized in that said axial rate sensor comprises an axial magnetization magnet ring attached to said rotor and associated to polar pieces closing the magnetic flux on either side of coils connected to said stator and located in the gap constituted between said polar pieces.
14. An equipment as claimed in claims 1, 2, 3, or 4, characterized in that said motor and said generator are incorporated in a single unit having only one armature and one inductor.
15. An equipment as claimed in any of claims 1, 2, 3, or 4, characterized in that said motor and said generator comprise a motor at an axial end of said rotor and said stator, and a generator at the other axial end of said rotor and said stator.

16. An equipment as claimed in claims 1, 2, 3, or 4, characterized in that said motor and said generator comprise a separate motor and a separate generator connected to act as two motors for increased power of rotation of said rotor and as two generators to obtain increased power and increased time period of power output.
17. An equipment as claimed in claims 1, 2, 3, oe 4, characterized in that said enclosure is hermetically sealed and extends advantageously below the ground surface.
18. An equipment as claimed in claims 1, 2, 3, or 4, characterized in that said enclosure is hermetically sealed and comprises at least two parts constituting said enclosure, a pair of spaced sealing rings between said parts of said enclosure, a material having a low vapor pressure filling the space between said scaling rings.
19. An equipment as claimed in claim 18, characterized in that said material having a low vapor pressure is an oil.
20. An equipment as claimed in claim 18, characterized in that said material having a low vapor pressure is a resin.
21. An equipment as claimed in claim 20, characterized in that surfaces of said enclosure adjacent to said material having a low vapor pressure are treated with material to avoid too strong adherence of said resin to said surfaces to allow disassembly of said enclosure.
22. An equipment as claimed in claims 1, 2, 3, or 4, wherein said centering member of said damping device comprises a plurality of short-circuited coils passing between said opposing permanent magnets of said damping device.
23. An equipment as claimed in claim 22, wherein said plurality of coils form coil pairs due to the even number thereof and in

that an amplifier connects one of said coils in each pair to the other of said coils.

24. An equipment as claimed in claim 23, wherein said amplifier of said damping system is operated for predetermined time periods.

25. An equipment as claimed in claims 1, 2, or 3, wherein a radial rate sensor to detect the radial rate of excursion of said rotor comprises coils mounted adjacent a magnet fixed to said rotor and in that damping means to prevent excessive radial excursion rate of rotation comprises an armature of ferromagnetic alloy fixed to said stator, a coil fixed to said armature and a permanent magnet ring having polar pieces at its ends and affixed to said rotor.

26. A method of storing energy under kinetic form and uninterrupted restoration of said energy in electric form, in a field of gravity characterized by comprising the steps of starting a steel rotor in rotation into a magnetically suspended unstable equilibrium by a lift-off logical determination from supporting bearings, said equilibrium being defined by compensation of weight with opposite magnetic permanent forces, building a source of uninterrupted power by increasing rotation of said rotor up to a predetermined maximum speed, switching from an electric power input to an electric power output upon loss of power input by obtaining the power output from kinetic energy in the rotor, and continuing rotation in magnetically suspended equilibrium from stored kinetic energy in the rotor.

27. A method as claimed in claim 26, characterized in that the lift-off logic conditions comprise a determination by measurement of the maximum current.

28. A method as claimed in claim 26, characterized in that the lift-off logical determination comprises measurement of a predetermined time period.

29. A method as claimed in claim 26, characterized in that the rotation of the steel rotor flywheel takes place in an enclosure from which air has been evacuated.

30. A method as claimed in claim 29, characterized in that said enclosure in which said steel rotor flywheel is placed is sunk below the surface of the ground.

31. A method as claimed in claim 26, characterized by providing a composite rotor permitting increase of the stored energy.

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L9: Entry 5 of 7 File: USPT Feb 5, 1980

US-PAT-NO: 4186623
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TITLE: Multi-rim flywheel attachment

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INVENTOR-INFORMATION:

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US-CL-CURRENT: 74/572; 156/74, 156/75, 29/894, 474/190

CLAIMS:

We claim:
1. A method of storing energy in a flywheel having a shaft with spokes of a predetermined radius and a plurality of nested rims having an inner radius less than the radius of said spokes, said method comprising the steps of:
positioning spacer means between each pair of adjacent rims in radial alignment corresponding to each of said spokes;
positioning the rim assembly on the spokes of said shaft in a non-circular configuration with said spacer means aligned with said spokes to increase non-circularity of the rim outside each of said spacer means; and
causing rotational motion of said flywheel at a speed at which said rim assembly assumes a substantially circular configuration.
2. A method of constructing a flywheel having a shaft with spokes of a predetermined radial dimension, said method comprising the steps of:
forming a plurality of nested cylindrical rims having an inner radius less than said predetermined radial dimension;
positioning spacer means between each adjacent pair of said rims in radially aligned sets;
deforming said cylindrical rim to produce a plurality of enlarged points on said rims having a radial dimension not less than said predetermined radial dimension, each of said sets of spacer means being positioned at one of said enlarged points to increase the radial dimension of said enlarged points outside said spacer means;

mounting said rims on said spokes with the enlarged points respectively aligned with said spokes; and
releasing said rims to firmly engage said spokes.
3. A method of constructing a flywheel having a shaft with spokes of a predetermined radial dimension, said method comprising the steps of:
forming first rim means on the spokes of said shaft in a non-circular configuration;
positioning first spacer means on said first rim means at positions radially aligned with said spokes; and
forming second rim means around said first rim means and spacer means such that the non-circularity of said second rim means is enhanced by said spacer means.
4. The method of claim 3 including the additional steps of:
positioning additional spacer means on said second rim means radially aligned with said spokes; and
forming third rim means around said second rim means and additional spacer means.
5. A flywheel comprising hub means, and a plurality of nested rims positioned on said hub means, said rims having a non-circular configuration with a plurality of enlarged points when said flywheel is at rest and having a substantially circular configuration when said flywheel is spinning at a preselected speed, a plurality of spacer means being positioned between adjacent pairs of rims in radial alignment at each of said enlarged points for increasing non-circularity of the rim outside each of said spacer means.
6. A flywheel as in claim 5 wherein said hub means has a plurality of spokes, and said plurality of nested rims are positioned on said spokes with said enlarged points and said spacer means in radial alignment with said spokes.
7. A method of constructing a flywheel having at least two rims disposed around a hub having a plurality of spokes, said method comprising the steps of:
constructing a first tubular rim;
securing spacers at predetermined positions around said first tubular rim;
constructing a second tubular rim on the first tubular rim and spacers without adhesion between the second rim and said first tubular rim and spacers; and
mounting the first rim, spacers and second rim in a non-circular configuration on said hub with said spacers in radial alignment with said spokes for increasing the non-circularity of said second rim.
8. The method of claim 7 wherein the step of constructing said first tubular rim comprises the steps of:
winding filament material in a matrix on a form; and
curing said filament and matrix materials.
9. The method of claim 8 wherein said step of constructing said second tubular rim comprises the steps of:
winding filament material in a matrix around said first tubular rim and spacers; and
curing said second tubular rim.
10. A flywheel comprising:
hub means and a plurality of nested rims positioned on said hub means first rim means having a plurality of enlarged points generally uniformly distributed therearound;

a plurality of spacer means positioned around an outer surface of said first rim means at each of said enlarged points; and second rim means having a plurality of enlarged points generally uniformly distributed therearound mounted on said first rim means and said spacer means with the radial dimension of each enlarged point of said second rim means enhanced by said spacer means.

11. The flywheel of claim 10 including means for securing said spacer means to one of said first and second rim means.

12. The flywheel of claim 10 including hub means positioned in supporting relation within said first rim means.

13. The flywheel of claim 12 wherein said hub means has a plurality of spoke means and said enlarged points and spacer means are distributed in radial alignment with said spoke means.

14. The flywheel of claim 10 additionally including:
an additional plurality of spacer means distributed around an outer surface of said second rim means in radial alignment with said first plurality of spacer means; and
third rim means mounted on said second rim means and said additional spacer means.